

REMARKS

This Amendment is filed in response to the Office Action dated August 11, 2004, which has a shortened statutory period set to expire November 11, 2004.

Applicants Have Reinstated Claims 1-10, 12-32, 34-36, and 44-54

The first Office Action dated October 16, 2003, the final Office Action dated April 2, 2004, and the Advisory Action dated June 16, 2004 all indicate that Claims 11, 33, and 37-43 were objected to as being dependent on a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. To reach resolution regarding these claims, Applicants amended Claims 11, 33, and 37-40 to be independent claims (Claims 41-43 depend from Claim 40 and therefore were not amended) and cancelled Claims 1-10, 12-32, 35-36, and 44-54.

The second (non-final) Office Action dated August 11, 2004 now rejects Claims 11, 33, and 37-43 as being anticipated by Agrawal, i.e. the same reference previously used to reject Claims 1-10, 12-32, 34-36, and 44-54. Therefore, apparently no resolution, even with respect to Claims 11, 33, and 37-43, can be achieved. As a result, Applicants have reinstated Claims 1-10, 12-32, 35-36, and 44-54, thereby ensuring all claims can be reconsidered and appealed, if necessary.

In light of these reinstated claims, Applicants have reiterated their remarks regarding traversals of characterizations of Agrawal provided in the previous Office Actions.

Claims 1-54 Are Patentable Over Agrawal

Agrawal teaches layout processing to an IC layout using a shape-based identification system. Col. 3, lines 19-22. A library of layout processing actions associated with the shapes can be rule-based, model-based, or can provide any other response a user would like implemented (i.e. "layout processing" can include OPC, phase shift mask (PSM), design rule checking (DRC), "fracturing" of layout features for e-beam mask making machines etc.). Col. 3, line 63 to col. 4, line 1.

Notably, Agrawal fails to disclose or suggest layout beautification or a layout imperfection as recited in Claims 1 and 12. As taught by Applicants in paragraph [0004], layout imperfections can significantly increase data volume for a particular IC layout, thereby undesirably increasing layout processing (e.g. OPC, DRC, etc.) and mask production times.

Note that performing layout beautification is not the same as correcting for optical proximity, as taught by Applicants in paragraphs [0003]-[0006] of the Specification (quoted below for the Examiner's convenience).

[0003] Automated design tools can be used to perform various operations on an IC layout. For example, an automated tool might be used to make optical proximity correction (OPC) modifications or perform design rule checking (DRC) on an IC layout. An automated tool could even be used to create the actual IC layout from a design netlist.

[0004] However, while automated tools enable the accurate creation of IC layouts, the complex interactions of the rules embodied in those tools can result in layout imperfections. In other words, while the results of an automated tool may be electrically correct (and even optically correct), the polygons that make up the actual IC layout might include unintended irregularities. These "layout imperfections" are not necessarily defects in the sense that the IC layout may still be electrically correct.

However, these layout imperfections may adversely affect layout printability or device performance. Also, such imperfections can significantly increase data volume for a particular IC layout, thereby undesirably increasing layout processing (e.g., OPC, DRC, etc.) and mask production times.

[0005] For example, Fig. 1a shows a simple polygon 100 made up of edges 101-108. Polygon 100 could represent a simple wire or interconnect in an IC layout. A notch 111 in the side of polygon 100 represents a common type of layout imperfection. If notch 111 is small, it may cause no significant electrical or optical problems. However, as shown in Fig. 1b, during a fracturing operation notch 111 causes polygon 100 to be split into primitives 121, 122, and 123, along fracture lines 131 and 132. In contrast, Fig. 1c shows a polygon 140 that is substantially similar to polygon 100, but does not have the same notch-type imperfection. As a result, polygon 100 would fracture into a single primitive. Thus, the small imperfection in polygon 100 (i.e., notch 111 shown in Fig. 1b) results in a three-fold increase in data volume after a fracturing operation.

[0006] Unfortunately, due to the complexity of modern IC layouts, detecting and correcting this type of layout imperfection (a technique sometimes referred to as "layout beautification") can be difficult.

OPC involves modifications of the original IC layout to compensate for distortions introduced by the exposure process. Agrawal, col. 1, lines 33-39. As described in the Specification, paragraph [0004] (see above), performing OPC (or other automatic layout modifications) can result in the need for layout beautification. Thus, it logically follows that performing a layout beautification operation would occur after performing optical proximity correction (OPC).

Unfortunately, various Office Actions confuse the distinctions between OPC and layout beautification. For example, col. 2, lines 13-20 of Agrawal teach that OPC

modifications can be applied to a "finger" layout feature, which is common in IC layouts. Therefore, this passage fails to disclose or suggest performing layout beautification.

Col. 3, lines 23-30 of Agrawal teach that a catalog of shapes can be defined and layout processing actions can be formulated based on the properties of the various shapes. Applicants submit that the catalog of shapes for OPC would differ from the catalog of shapes for layout beautification. Therefore, this passage fails to disclose or suggest performing layout beautification.

Figs. 10a and 10b of Agrawal illustrate a shape-based OPC system and OPC engine, respectively. These figures fail to disclose or suggest that an OPC engine and a layout beautification engine have equivalent functions.

Col. 8, lines 51-54 of Agrawal teach that the shapes/actions of a layout modification system may be provided as defaults by the system, or the user may add or modify shapes/actions as desired. This passage fails to disclose or suggest a second set of instructions for performing a first layout beautification action on each of the first set of matching layout features as recited in Claim 32.

Col. 20, lines 23-24 of Agrawal teach that computer software for performing layout processing can include code for applying a first action to a first set of layout features. This passage also fails to disclose or suggest a second set of instructions for performing a first layout beautification action on each of the first set of matching layout features as recited in Claim 32.

Applicants traverse other previous characterizations of Agrawal as teaching a layout imperfection. For example, col. 4, lines 18-27 of Agrawal teach that shape matching can be performed in any number of sequences. For example, shape

matching can be performed in order of decreasing shape complexity, in order of increasing shape complexity, or in a user-desired order. Therefore, col. 4, lines 18-27 fails to teach a layout imperfection.

Figs. 4a-4c of Agrawal illustrate various sample shapes in a shape-based rule library. Col. 5, lines 7-8. Therefore, these figures teach nothing regarding a layout imperfection.

Table 2, provided in col. 6, lines 25-34 of Agrawal, lists various exemplary shape properties that can define the edges of each individual shape. Col. 6, lines 14-24. Thus, Table 2 fails to teach layout imperfections.

Col. 8, lines 49-61 of Agrawal teach that a layout modification system includes a bias table capturing a set of actions based on a catalog of shapes. The shapes/actions may be provided as defaults by the system, or the user may add or modify shapes/actions as desired. In one embodiment, a GUI allows a user to define PSM and OPC actions to be applied upon detection of particular shapes. Thus, col. 8, lines 49-59 fails to teach a layout imperfection.

Col. 10, lines 37-47 of Agrawal teach that if a sequential action operation is being performed (after the first shape is compared), then the action associated with the first shape is applied to the matching layout features. A second shape can then be selected from the shape catalog. After a second match operation, the action associated with the second shape can be applied to the layout geometry. Therefore, col. 10, lines 37-47 fails to teach layout imperfections.

Col. 10, line 60 to col. 11, line 20 of Agrawal teach a possible outcome of an action conflict originating in a shape conflict. Specifically, the cross-like shape of feature F3' in Fig. 9c is produced as the serifs from action A physically overlap with the extended region generated by action B.

Therefore, in some embodiments, conflict resolution logic can be included. Col. 10, lines 21-23. Neither the conflicts nor the conflict resolutions teach anything regarding layout imperfections.

Col. 14, lines 20-31 of Agrawal teach that a definition of first shape can be accessed. The first shape includes first and second edges coupled in accordance with certain properties. A first action can be accessed, wherein the first action is based on a first portion of a first plurality of properties. The first action specifies the application of a first layout modification. A first set of layout features with the first shape and the first portion of the first plurality of properties can then be matched. At this point, the first action can be applied to the first set of layout features. Thus, col. 14, lines 20-31 fails to teach a layout imperfection.

Because Agrawal fails to disclose or suggest layout beautification and layout imperfections, Applicants request allowance of Claims 1 and 12.

Claims 2-10 depend from Claim 1 and therefore are patentable for at least the reasons presented above for Claim 1. Based on those reasons, Applicants also request reconsideration and withdrawal of the rejection of Claims 2-10.

Claim 11 recites layout beautification as well as layout imperfections. Therefore, Claim 11 is patentable for at least the reasons presented for Claims 1 and 12. Based on those reasons, Applicants request allowance of Claim 11.

Claims 13-18 depend from Claim 12 and therefore are patentable for at least the reasons presented above for Claim 12. Based on those reasons, Applicants also request reconsideration and withdrawal of the rejection of Claims 13-18.

Claim 19 recites a layout beautification engine. As taught by Applicants, layout beautification includes detecting and

correcting layout imperfections. Specification, paragraph 0006. Applicants submit that Agrawal fails to disclose or suggest a layout beautification engine.

Applicants respectfully traverse any previous characterizations that Agrawal teaches this limitation. Specifically, col. 12, lines 49-60 of Agrawal teach that an OPC engine can receive a set of geometries and performs shape matching as well as action application to the set. As pointed out above, an OPC engine performs a different function than a layout beautification engine. Therefore, col. 12, lines 49-60 fail to disclose or suggest a layout beautification engine. For the above reasons, Applicants request allowance of Claim 19.

Claims 20-25 depend from Claim 19 and therefore are patentable for at least the reasons presented above for Claim 12. Based on those reasons, Applicants also request allowance of Claims 20-25.

Claim 26 recites a system for performing layout beautification on an IC layout data file. Therefore, Claim 26 is patentable for substantially the reasons presented above for Claim 19. Based on those reasons, Applicants also request allowance of Claim 26.

Claims 27-31 depend from Claim 26 and therefore are patentable for at least the reasons presented above for Claim 26. Based on those reasons, Applicants also request allowance of Claims 27-31.

Claim 32 recites a software program for performing layout beautification on a plurality of polygons in an IC layout. This software program includes a second set of instructions for performing a first layout beautification action on each of the first set of matching layout features. Therefore, Claim 32 is patentable for substantially the reasons presented above for

Claim 19. Based on those reasons, Applicants also request allowance of Claim 32.

Claim 33 recites a software program for performing layout beautification on a plurality of polygons in an IC layout. This software program includes a second set of instructions for performing a first layout beautification action on each of the first set of matching layout features. Therefore, Claim 33 is patentable for substantially the reasons presented above for Claim 19. Based on those reasons, Applicants also request allowance of Claim 33.

Claims 34-36 depend from Claim 32 and therefore are patentable for at least the reasons presented above for Claim 32. Based on those reasons, Applicants also request allowance of Claims 34-36.

Claims 37, 38, 39, and 40 recite a software program for performing layout beautification on a plurality of polygons in an IC layout. This software program includes a second set of instructions for performing a first layout beautification action on each of the first set of matching layout features. Therefore, Claims 37, 38, 39, and 40 are patentable for substantially the reasons presented above for Claim 19. Based on those reasons, Applicants also request allowance of Claims 37, 38, 39, and 40.

Claims 41-43 depend from Claim 40 and therefore are patentable for at least the reasons provided for Claim 40. Based on those reasons, Applicants request allowance of Claims 41-43.

Claim 44 recites an apparatus for reducing output data size in an input layout by beautifying the input layout. Therefore, Claim 44 is patentable for substantially the reasons presented above for Claim 19. Based on those reasons, Applicants also request allowance of Claim 44.

Applicants now traverse various characterizations provided in previous Office Actions regarding Claim 44.

Col. 8, lines 37-48 of Agrawal teach that once a catalog of shapes is specified, actions may be formulated as functions of the property variables of those shapes. Actions may include instructions to perform a modification, e.g. a rule-based OPC, or any other response to a particular set of parameters. This passage fails to disclose or suggest an apparatus for reducing output data size in an input layout by beautifying the input layout as recited in Claim 44.

Col. 12, line 21 of Agrawal teaches that an OPC system can include input and output data managers. Col. 12, lines 41-48 teach that a hierarchy manager organizes and categorizes the sets of geometries according to a predefined ordering basis (e.g. to minimize the amount of data required to be processed or to minimize the time required for processing). The hierarchy manager then feeds the sets of geometries to an OPC engine according to its priority structure. Neither of these cited sections disclose or suggest beautifying the input layout.

Col. 12, lines 54-57 and col. 15, lines 44-46 of Agrawal teach that a data controller can segregate the data into primitives, i.e. elements appropriate for a shape scanner. As taught by Applicants in the Specification, paragraph [0005] (see above) and referring to Figs. 1a and 1b, even a small imperfection in a polygon can result in a significant increase in data volume after a fracturing operation. Therefore, it is unclear how the segmentation of Agrawal, without layout beautification, can result in reducing output data size as recited in Claim 44.

Fig. 10b of Agrawal illustrates an exemplary OPC engine. This figure fails to disclose or suggest an apparatus for

reducing output data size in an input layout by beautifying the input layout as recited in Claim 44.

Claim 45 depends from Claim 44 and therefore is patentable for at least the reasons presented above for Claim 44. Based on those reasons, Applicants also request allowance of Claim 45.

Claim 46 recites modifying the layout according to corrective actions associated with the identified shape patterns, thereby removing at least one layout imperfection. Therefore, Claim 46 is patentable for substantially the same reasons as presented for Claims 1 and 12. Based on those reasons, Applicants also request allowance of Claim 46.

Claims 47-50 depend from Claim 46 and therefore are patentable for at least the reasons presented above for Claim 46. Based on those reasons, Applicants also request allowance of Claims 47-50.

Claim 51 recites a shape-based beautification method in a layout. Therefore, Claim 51 is patentable for substantially the reasons presented above for Claim 19. Moreover, this method applies at least one correction to an identified shape pattern, thereby removing at least one layout imperfection and reducing fracturing data volume in the layout. Therefore, Claim 51 is further patentable for substantially the reasons presented above for Claims 1 and 12. Based on all of the above reasons, Applicants request allowance of Claim 51.

Claims 52-54 depend from Claim 51 and therefore are patentable for at least the reasons presented above for Claim 51. Based on those reasons, Applicants also request allowance of Claims 52-54.


CONCLUSION

Claims 1-54 are pending in the present application.
Applicants request allowance of these claims.

If there are any questions, please telephone the undersigned at 408-451-5907 to expedite prosecution of this case.

Respectfully submitted,

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CERTIFICATE OF TRANSMISSION (37 C.F.R. 1.8(a))

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